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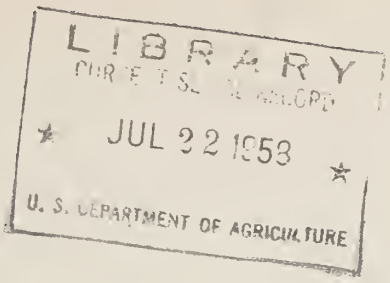


# SPRUCE SPIDER MITE INFESTATIONS IN NORTHERN ROCKY MOUNTAIN DOUGLAS-FIR FORESTS

by

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## INTRODUCTION

Epidemic infestations of the spruce spider mite, Oligonychus ununguis (Jacobi) (Acarina: Tetranychidae), with attendant severe host tree damage were observed early in August 1957 in Douglas-fir stands on the western slopes of the Big Belt Mountains east of Helena, Montana, and within the Helena National Forest. Subsequent surveys employing aerial observation and ground examinations disclosed other extensive infestations of the mite in various parts of Montana and southern Idaho. The sudden appearance of these infestations over such wide areas, the apparent severe nature of the mite feeding on the host trees, and the seeming relationship between the occurrence of the mite infestations and large-scale operations to control the spruce budworm (Choristoneura fumiferana (Clem.)), occasioned considerable interest and some concern among foresters and timberland owners in the affected areas.

Because of this unusual occurrence it is considered timely to present information on this particular species. The material presented has been assembled from scattered published and unpublished references, from the freely offered experience of several acarologists and entomologists, and from field observations of the 1957 mite infestations.

## THE SPRUCE SPIDER MITE

### DESCRIPTION

The spruce spider mite is an arthropod belonging to the class Arachnida which includes the 8-legged spiders, scorpions, mites, and ticks. It is not an insect, which is a 6-legged arthropod belonging to the class Hexapoda.

The spruce spider mite has been recognized in entomological literature under several synonyms: Tetranychus ununguis Jacobi, 1905; Paratetranychus ununguis Zacher, 1913; Oligonychus ununguis Hirst, 1920; T. uniunguis Ewing, 1917; Neotetranychus uniunguis McGregor, 1919; P. uniunguis McGregor, 1950; O. americanus Ewing, 1920; P. americanus McGregor, 1950; P. alpinus McGregor, 1936; and P. pini Hirst, 1924 (17).[1/]

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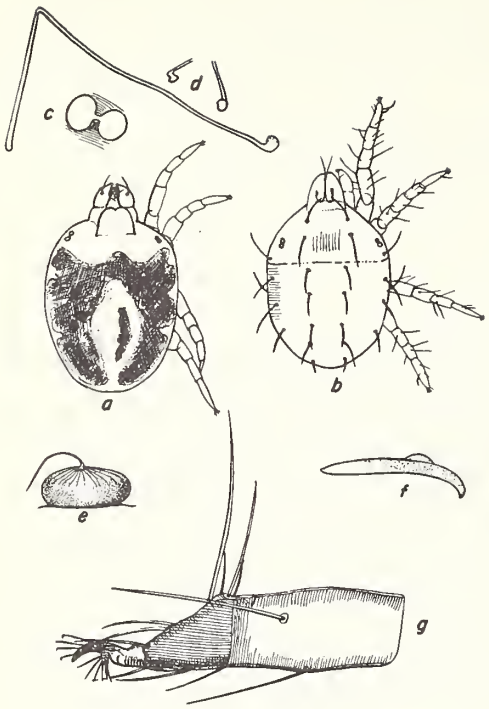
1/ Numbers in parentheses refer to LITERATURE CITED, page 13




The life stages of the spruce spider mite consist of egg, larva (provided with three pairs of legs instead of four), two nymphal stages, and the adult. Adult mites are oval, 8-legged animals, sparsely covered with long setae, and have piercing and sucking mouthparts. The body appears dark green or nearly black except for a middorsal pale streak (fig. 1). The propodosoma and legs are flesh-colored and the eyespots are conspicuous. Coloration of the male and female is similar.

Figure 1.--Oligonychus ununguis (Jacobi). a. Adult female color pattern. b. Adult female, dorsal view showing spines. c. Eyes. d. Collar tracheae. e. Egg in lateral view. f. Penis. g. Tarsas I. All greatly enlarged. (Courtesy Connecticut Agricultural Experiment Station.)

The adults are small, their average length being 0.40 mm. for females and 0.32 mm. for males; average width at widest portion 0.25 mm. for females and 0.15 mm. for males. They are scarcely visible to the naked eye except when they move about fairly rapidly over the host plant (3, 11).

The globular, shiny eggs are amber colored (pale when first laid), sometimes reddish, depressed or flattened, striated on the sides, and have a central single hair or seta. Viewed dorsally, the egg diameter averages 0.15 mm.

The newly hatched larva is very uniformly flesh-colored, later turns to a dark green. The larva is 6-legged.

Both nymphal stages (protonymph and deutonymph) resemble the adult mite in general size, shape, and color.

## LIFE HISTORY

The life history of the spruce spider mite as reported by Garman (10) and by Peterson and Hovey (16) agrees with that made from observations in Montana in 1957, as interpreted by Morgan.[2/] The mite overwinters in the egg stage, with winter eggs being laid singly, or in masses, on the lower surface of the Douglas-fir twigs. Eggs begin to hatch in late April, the date depending upon air temperatures. Several mite generations develop throughout the summer. Individual summer generations develop rapidly, sometimes with as few as 14 elapsed days between egg and adult stages. As a result, overlapping of summer generations is a common occurrence.

All active stages feed on the host plant and spin a very fine web. Some observers have noted heavy webbing by the spruce spider mite on the twigs and among the needles. Webbing on Douglas-fir did not appear abundantly in most of the infested foliage examined from the Montana outbreak of 1957. Occasional samples exhibited fairly abundant webbing.

Winter eggs are deposited on the fir twigs during the period July through September. By the end of October few adult mites are still alive.

## HOSTS

The spruce spider mite is a pest of coniferous forest trees and certain ornamental evergreens. It has damaged spruce trees in Canada (5), spruce, red pine, and cedars in Connecticut (10, 11), and pine in Ohio (14). In 1930 an outbreak of this mite killed a large number of lodgepole pine trees in eastern Oregon (6). It has been identified on Douglas-fir Christmas trees in British Columbia and Alberta,[3/] and in northern Idaho, Montana, and Colorado but without any evident damage.

The favorite hosts of the mite are reported by Pritchard and Baker to be Juniperus, Cupressus, Thuja, Chamaecyparis, Libocedrus, and Picea; also it has been collected from redwood and sequoia in California (17).

Mature Douglas-fir trees along the Madison River in Yellowstone National Park, Wyoming, became heavily infested by the spruce spider mite in 1929, but the infestation declined in 1931 with no significant tree mortality. Other infestations, presumably by the same mite, were recorded in 1929 on Douglas-fir

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2/ Verbal confirmation by C. V. G. Morgan, acarologist, Fruit Insect Section, Science Service Laboratory, Canada Department of Agriculture, Summerland, B. C.

3/ Confirmation of Canadian occurrence records was supplied by correspondence from technicians of the Laboratories of Forest Biology, Science Service, Canada Department of Agriculture at Vernon, B. C., and Calgary, Alberta, Canada.

trees at Jackson Hole, Wyoming, and on spruce trees between West Thumb and Old Faithful in Yellowstone National Park, Wyoming (7, 9). These constitute the first records of Douglas-fir forests as a host of the spruce spider mite.

The host in the known forest outbreaks of the mite has been blue, or Rocky Mountain, Douglas-fir, Pseudotsuga menziesii var. glauca (Beissn.) Franco. No mite outbreaks have thus far been recorded from forests of typical, or Coast, Douglas-fir, P. menziesii var. menziesii (Mirb.) Franco.

## INJURY

External evidence of mite damage to Douglas-fir host trees is almost wholly limited to foliage discoloration, or chlorosis, caused by the mites' feeding on needles. The spruce mite feeds voraciously in the larval, protonymphal, deutonymphal, and adult stages. All are equipped with sucking mouthparts consisting, in part, of short, minute stylets that are inserted into the epidermal and palisade cells of the fir needles. Mites extract the chlorophyll content of these cells and use it as primary food. Inasmuch as the chlorophyll is not replaced, the cells die. If enough cells are thus destroyed, the needles die.

Chlorosis develops on the needle surface at the point of feeding. If mite feeding is not too severe, undamaged needle surface areas having a normal green color will be interspersed with chlorotic areas, giving the needles a mottled coloration. Acarologists commonly refer to this as "salt and pepper" mottling. Tree crowns containing these needles, even in abundance, are only slightly discolored. The function of the needles is not greatly impaired, and damage to the tree may be restricted to a small reduction in radial and longitudinal increment for the year.

When needles are entirely yellow or buff colored from very heavy mite feeding, they may die and drop from the tree. Partial loss of foliage in this manner causes severely reduced increment, and complete foliage loss may cause death of the tree. Mites are fully capable of killing trees in this manner, but to date such killing of Douglas-fir has been insignificant.

In the 1957 infestation of the spruce spider mite in Montana, 464,800 acres of Douglas-fir forest showed only the mottled, or "salt and pepper," type of damage indicative of light to moderately heavy feeding. An estimated 334,000 acres were entirely discolored by very heavy mite feeding. The eventual tree mortality, if any, from this feeding is yet to be ascertained.

Symptoms of mite damage in the Montana outbreak appeared with simultaneous suddenness everywhere throughout the 798,800 infested acres. The host tree damage appeared to have developed more heavily in dense, even-aged, immature fir stands, but many adjacent stands having similar characteristics were not damaged. The outbreak was composed of numerous, scattered, localized infestations made up from those containing only a few mite-damaged trees to those where all the trees were damaged on areas up to 1,000 acres or more.

Accompanying the needle chlorosis are other symptoms that are not directly indicative of host tree damage, but that serve mainly to substantiate the presence of the spruce spider mite. These are the meager though sometimes abundant webbing on the twigs and needles, the dirt and filth on the twigs and needles usually associated with spruce spider mite activity, cast larval and nymphal skins, the shells of hatched, or predatorized eggs, and summer or winter eggs. Twigs and needles on infested trees along unsurfaced roads are frequently coated with dust enmeshed in the webbing.

Associated with spruce spider mite damage is a probability of increased susceptibility of pole- or sawlog-size host trees to attacks of the Douglas-fir beetle, Dendroctonus pseudotsugae Hopk. Trees weakened physiologically, as from mite-caused chlorosis, may be attacked and killed by the beetle more frequently than healthy trees. Under favorable conditions, the subsequent killing of mite-damaged trees by the beetle could result in greater economic loss than the loss of increment or tree mortality directly attributable to the mite.

## SPRUCE SPIDER MITE INFESTATIONS

### OCCURRENCE

Four epidemic outbreaks of the spruce spider mite have been recorded in Rocky Mountain Douglas-fir forests. These include the outbreak in Jackson Hole, Wyoming, in 1929, about which little is known; that along the Madison River in Yellowstone National Park, Wyoming, in 1929; one in Colorado in 1949; and the most recent one in several national forests in Montana and Idaho in 1957.

The Madison River outbreak of 1929, reported by Evenden (7), resulted in rather severe tree injury from very large numbers of what was erroneously identified as the clover mite Bryobia praetiosa Koch.[4/] He recorded the termination of the outbreak in 1931 from natural causes (9). The mite-infested area was contiguous to a narrow strip of lodgepole pine forest 150 yards x 10 miles previously sprayed with lead arsenate[5/] by ground equipment to control damaging infestations of the lodgepole sawfly, Neodiprion burkei Midd., and the pine tube moth, Argyrotaenia pinatubana Kearf. (2). This spraying was done during June and July in 1924, 1925, 1926, and 1927 in the pine strip extending from West Yellowstone, Montana, to Madison Bridge. The mite infestation in 1929-31 was centered near the bridge and probably covered no more than 1,000

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4/ Evenden in his 1943 report refers to this mite species as Oligonychus americanus Ewing (obviously a typographical error and meant to be O. americanus Ewing), now synonymous with O. ununguis (Jacobi).

5/ Powdered arsenate of lead, 3,800 pounds; fish oil, 140 gallons; and water, 60,800 gallons.

acres. Evenden states (8) that, "This is the first record which we have of this pest becoming a serious enemy of forest trees. Though the foliage of the infested trees was severely injured, no control measures were recommended due to the expense of the operation, and because it was believed no permanent damage to the trees would follow."

An outbreak near Evergreen, Colorado, in 1949 covered 100 acres of Rocky Mountain Douglas-fir. The area had been aerially sprayed with DDT[6/] in 1948 to control an infestation of the Douglas-fir tussock moth, Hemerocampa pseudotsugata McD. Chlorosis from mite feeding was severe, but no tree mortality was reported as a result of the outbreak which lasted one year.[7/]

Another outbreak, presumably by the spruce spider mite, occurred in 1956 in the Lincoln National Forest near Lost Lodge, New Mexico. The mite infestation covered 50 acres in a Douglas-fir stand sprayed for spruce budworm control in 1955. The outbreak continued unabated in 1957, but no tree mortality occurred in either year.[8/]

The spruce spider mite infestations of 1957 were by far the most extensive and the most spectacular in the suddenness of their appearance, their probable over-all effect on the infested fir forest, and their possible impact upon future forest insect control policies involving use of certain insecticides. These infestations were scattered in several large blocks of the Helena, Lewis and Clark, Deerlodge, and Beaverhead National Forests in Montana and of the Boise and Payette National Forests in Idaho. The Montana infestions in 1957 covered areas totaling about 798,800 forested acres, all of which were part of 885,000 acres of Douglas-fir type treated by aerially applied DDT insecticide[9/] in July 1956 for control of the spruce budworm.

The 1957 mite infestations in Idaho totaled 22,000 acres, all of which were a part of 476,000 acres of fir forests sprayed with DDT for spruce budworm control in 1956.

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6/ Technical DDT, one pound; auxiliary hydrocarbon solvent, 1.25 quarts; and #2 fuel oil to make one gallon at 60°F. Applied from airplanes flying from 200 to 400 feet above the forest canopy as a mist, with particle size from about 150 to 250 microns, at the rate of one gallon of mixed insecticide when the majority of the budworm larvae were in the 5th and 6th instars to achieve 95+ percent budworm mortality.

7/ Confirmed in correspondence from Dr. N. D. Wygant, entomologist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Fort Collins, Colorado.

8/ Confirmed by Dr. Calvin L. Massey, entomologist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Albuquerque, New Mexico.

9/ See footnote 6, above.

Some spruce spider mite damage, extent unknown, was observed in August 1957 on Douglas-fir trees within spruce budworm control units aerially sprayed with DDT in July 1955 in Yellowstone National Park, Montana-Wyoming, and on the Boise and Payette National Forests, Idaho.

The spruce spider mite increases in numbers during hot weather and becomes quite damaging to host plants during periods of drought. During such times it appears to escape the population-inhibiting influence of predaceous mites and insects.

Severe infestations may also build up following the spraying of host trees with DDT to control insect pests. DDT is not toxic to the spruce spider mite. Some acarologists have hypothesized that DDT may even affect the reproduction potential and the living habits (4) of the mite or cause physiological changes in the sprayed tree which increases its desirability as a mite host. DDT is highly toxic to the predaceous typhlodromid mites and to the primary insect predators of the spruce mite.

The spruce spider mite infestations in Montana and Idaho apparently developed in 1957 as the combined result of (1) the killing of the predators by DDT spraying in 1956, (2) the occurrence of an unseasonably warm May in 1957 that favored the rapid development of spruce spider mite populations, and (3) adequate food in the form of extensive pure stands of dense Douglas-fir forests. The mite outbreak in Yellowstone National Park in 1929 may also have occurred following the previous use of an insecticide which, too, killed the mite predators, although this probably was not recognized as a possible cause of the outbreak at that time.

Assuming that the spruce spider mite infestations of 1957 in Montana and Idaho were related to the aerial use of DDT for insect control in Douglas-fir forests, it was the first recorded widespread occurrence on 7 million acres of fir forests in the western United States similarly treated with DDT between 1947 and 1956.

## DURATION

Duration of epidemic outbreaks of the spruce spider mite in Douglas-fir forests cannot be forecast accurately until additional experience is gained or until more is known of the factors governing their occurrence. The outbreak reported at Yellowstone National Park lasted 3 years, but foliage damage was confined to the first 2 years. No record is available of the duration of the Jackson Hole outbreak, but it apparently was short-lived since mention of it was made only in 1929. The outbreak of 1949 in Colorado subsided after one year.

It appears that natural outbreaks, or those following single applications of certain insecticides nontoxic to the spruce spider mite, may not persist for more than 1 or 2 years. Successive insecticide applications for insect pests in fir forests could conceivably maintain a prolonged mite outbreak if the applications were spaced at 2-year intervals or less and if environmental factors favored the increase of the mite.

It may be possible to forecast the duration of a mite epidemic for one additional year by measuring the abundance of winter eggs during the period September to April. The relative abundance of eggs and their viability might serve as a guide in determining whether mite infestations will be light or heavy the following summer. No studies have been made yet to correlate the abundance of winter eggs with the amount of resultant host tree damage that might result.

Viable eggs can be recognized by their turgidity and uniform color. Partially deflated or colored eggs indicate that predators have fed upon the contents. Inasmuch as such eggs will not hatch, abundance of them would indicate a downward trend or possibly even the termination of an existing mite infestation.

## NATURAL CONTROL

Spruce spider mite populations usually are maintained at endemic levels by normal weather conditions and by the effectiveness of several insect and acarine predators. Spruce spider mite populations develop more rapidly in the presence of drought conditions and where the host plants grow in dry sites or on poor soil. Absence of these conditions undoubtedly tends to keep populations at levels low enough to prevent host plant damage. Peterson and Hovey (16) report that extreme temperatures, strong winds, heavy rains, and very high humidities help to check the increase in spruce spider mite populations.

Among the most effective predators are (1) the predaceous mites of the genus Typhlodromus (Acarina: Phytoseiidae), (2) the ladybird beetle Stethorus picipes Casey (Coleoptera: Coccinellidae), (3) a small gall midge (Diptera: Cecidomyiidae), and (4) minute pirate bugs (Hemiptera: Anthocoridae). Typhlodromid mites were collected early in November from parts of the 1957 Montana spruce spider mite infestation. Their presence indicated that populations of these predaceous mites were reestablished following their supposed decimation by DDT insecticide in 1956.

## APPLIED CONTROL

### WASHING

Infestations of the spruce spider mite can be easily controlled on ornamental evergreens during the summer where water under pressure is available. Thorough washing of the foliage of infested trees with a forceful solid stream of water will break up the webbing and wash the mites away (15). Several repetitions of the treatment may be necessary.

Washing is believed to effect mite control in two ways: (1) by the separation of the pest and its host and (2) by the breaking up of the webbing which gives predaceous mites and insects freer access to the residual spruce spider mites (4).

## CHEMICALS

Most of the contemporary insecticides are ineffective in controlling spider mites. In fact, the use of certain of these killing agents often fosters mite outbreaks by destroying the insect and acarine predators. A number of chemical formulations have been developed, however, that are effective mite killers, or acaricides.

The organic phosphates such as TEPP, parathion, and malathion[10/] were adopted as acaricides soon after their introduction. Their repeated use on some agricultural crops, however, has resulted in the appearance of phosphate-tolerant strains among certain mite species. This required a new approach to mite control and led to the development of nonphosphate acaricides.[11/] These generally have proved highly effective in controlling mite infestations. Collectively they are called "selective miticides" inasmuch as they are highly toxic to mites but not to insects. For this reason, their use is not harmful to beneficial insects among which are bees and numerous insect parasites and predators. The nonphosphate acaricides are also noted for their persistency, for their relative low toxicity to man and other warm-blooded animals, and for the fact that they have not induced any resistance to them by various species of spider mites (18, 19, 20, 21).

Certain of the nonphosphate acaricides,[12/] in addition, can prevent mite outbreaks because of their specific toxicity to mite eggs and nymphs. They are less effective against adult mites.

Chemical control of the spruce spider mite on ornamental plants can be accomplished easily with any of the standard acaricides. Not only are they sufficiently toxic, but they can be applied at the recommended dosages from the ground by garden type or commercial spraying equipment to infested plants that are ordinarily accessible (15, 16, 20). Neiswander (15) reports the dusting of 46 acres of a nursery in Ohio by airplane in 1951 to control spruce spider mite infestations on arborvitae, spruce, juniper, and yew ornamental plants. Good control was achieved by applying a 10-percent Ovotran dust from the air at the rate of 30 to 35 pounds per acre.

The prevention or control of extensive forest infestations of spruce spider mite by chemicals, on the other hand, presents some problems which may prove difficult to overcome. One of the more obvious obstacles is the comparative inaccessibility and the rough topography of many of the Douglas-fir forests of the Rocky Mountains. These characteristics effectively preclude the

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10/ To avoid using long and complicated technical names of insecticides and acaricides, the common names of these materials are used here from the list compiled by the Committee on Insecticide Terminology of the Entomological Society of America for use in the JOURNAL OF ECONOMIC ENTOMOLOGY (Haller, H. L. 1957. Common names of insecticides. Jour. Econ. Ent. 50(2): 226-228).

11/ Aramite, Chlorobenzilate, Dimite, Kelthane, Sulphenone, and others.

12/ Ovex (Ovotran, Estomite, etc.), Mitox, Genite, Tedion, and Fensone.

application of acaricides from the ground. Their application from aircraft has so far appeared impractical because of the high dosage rates of most present day acaricidal formulations. Many of these formulations have been designed for use in ground spraying or dusting equipment to control mites in fruit orchards. Most of them are aqueous suspensions requiring the spraying of 600 to 1,200 gallons of formulated mixture per acre. This per acre dosage usually contains from 3 to 20 pounds of the 15- to 18-percent wettable powder form of the acaricidal toxicant. These formulations obviously are unsuited for dispersal by aircraft.

Oil solutions appear to be more suitable to application by aircraft. Brown (1) states that

> When wettable powders are applied in aqueous suspensions of approximately 0.1% concentration, the amount required for adequate coverage is of the order of 100 gal/acre, varying according to the crop. When the insecticide is applied in oil solutions from aircraft, in concentrations of approximately 5%, an area dosage of about 2 gal/acre is sufficient; a similar result may be obtained if concentrated suspensions are employed....Increasing fineness of atomization...and decreasing volatility of the carrier, allow even smaller amounts to achieve adequate coverage on foliage.

Each of the known forest infestations of the spruce spider mite has been short-lived. Applied control measures, even if available, probably would not have shortened their duration. The damage to the forest, even during such short periods, can be great enough, however, to consider seriously means of preventing these mite outbreaks with the use of acaricides.

Since the origin of spruce spider mite outbreaks appears to be associated with the use of certain aerially dispersed insecticides, principally DDT, for forest insect pest control, it has been suggested that insect control and spider mite prevention be combined in one operation. This might be done by the addition of acaricidal chemicals to the insecticide used for insect control. The development of a combination acaricide-insecticide for aerial dispersion must necessarily involve a number of considerations, several of which are listed:

1. Acaricidal and insecticidal materials should be tested in the laboratory and under field conditions to determine their respective toxicity to the spruce spider mite and to the insect pest in question.

2. Both materials should exhibit compatibility with each other and with solvents or other ingredients of the formulation.

3. The formulation must be capable of dispersion as a mist with spray systems now in general use for forest pest insecticides.

4. The formulation probably should not exceed the acute oral toxicity of DDT for warm-blooded animals or the median lethal water concentration of DDT for fish, and should be less if possible.

5. Phytotoxicity of the formulation should not exceed that of the standard DDT-oil solution now used for forest insect aerial spraying.

6. Dosage of the formulation should achieve the desired mite and insect kill with a single application, if possible, of no more than 1 gallon per acre.

7. The acaricidal element of the formulation should embody residual toxicity.

8. The cost of the acaricidal additive should not make the cost of the formulated mixture uneconomical for forest pest control.

The above considerations are for situations requiring the continued use of insecticides that have demonstrated an association with followup spider mite outbreaks. The problem of preventing these outbreaks might be solved more simply by using insecticides for forest pest control that do not encourage subsequent mite activity. This can only be done when such toxicants are developed.

## SUGGESTED STUDIES

The increasing widespread use of aerially dispersed DDT insecticides for forest pest control has revealed what appear to be isolated instances of temporary disturbance in the natural balance of forest fauna. Some of it is characterized by the upsetting of the host-predator relationships of some economically important pests. Development of spruce spider mite infestations following spruce budworm control operations in Douglas-fir forests may be one example of such a disturbance.

The present outbreak of the spruce spider mite suggests that it is possibly a potentially serious forest pest capable of causing intolerable increment loss or significant tree mortality in fir either by itself or from followup attacks of the Douglas-fir beetle. Until more definite knowledge is obtained about the capabilities of the mite as a pest, there will be some concern about continued use of some aerially dispersed insecticides in pest control programs.

Needed information probably will come from research on spruce spider mite epidemiology involving such studies as the following:

(1) The recognition of, and the ability to measure, endemic and epidemic populations of the mite.

(2) The amount and nature of the host tree damage caused by various population levels of the mite.

(3) The factors associated with the occurrence of epidemic mite populations.

(4) The development of feasible applied techniques to prevent or control mite infestations in the forest.

In addition, continued study is needed to determine the toxicity of acaricides to the spruce spider mite, the acute toxicity levels of these materials to terrestrial and aquatic fauna of the forest and to man, and the adaptability of their formulations to present forest aerial spraying technique.

## SUMMARY

Infestations of the spruce spider mite in Douglas-fir forests had been little-known prior to 1957. In this year scattered mite infestations were reported on nearly 800,000 acres of Douglas-fir forests in Montana and 22,000 acres of similar forests in southern Idaho. The infested forests were part of 885,000 acres of Douglas-fir forest type in Montana and 476,000 acres in southern Idaho that had been aerially sprayed with DDT in 1956 to control infestations of the spruce budworm.

Spruce spider mite biology and life history are described from literature, unpublished experiences of consultant entomologists and acarologists, and from field observations in 1957. The cause and extent of host tree chlorosis resulting from mite feeding is discussed. What appears to be a relationship between the use of DDT in forest insect control and the subsequent appearance and duration of spruce spider mite infestations is noted.

Acarine and insect predators are shown to be effective in the natural control of spruce spider mite populations. The use of certain nonphosphate acaricides in combinations with insecticides is suggested as a means of accomplishing control of existing forest insect infestations and preventing follow-up spider mite outbreaks. The possibility of using insecticides that do not foster subsequent mite activity is also mentioned.

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